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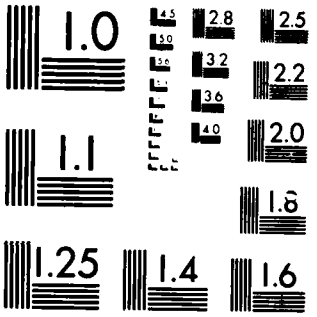

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The Ohio State University

JOINT SERVICES ELECTRONICS PROGRAM

The Ohio State University

ElectroScience Laboratory

Department of Electrical Engineering
Columbus, Ohio 43212

Final Report 710816-19
Contract N00014-78-C-0049
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OVERVIEW

1) Time Domain Studies and Slope Diffraction Techniques Studies initiated on JSEP have been combined into the creation of OSU's compact reflector/antenna range system (developed using other funding). This is the best system of its type currently available but it is expected that industry using concepts originated at OSU will soon surpass our current state of the art. These systems will have a large impact on stealth technology.

2) The Hybrid Studies focussed attention on the scattering from small inlet structures. Solutions have been developed which far exceed our original expectations. Funding from other sources has also become available. We can now treat very large rectangular or circular inlets using surprisingly simple solutions. The scattering from cracks using the hybrid approach has also been analyzed and indeed we have pointed out to several agencies that they may become dominant scatterers for stealth vehicles. These solutions also should be very useful to the researchers involved in the penetration (coupling) problem as discussed at the recent workshop at the Naval Post Doctoral School.

3) The Diffraction Studies have provided a rigorous solution for a wave propagating along a conducting edge. This has a serious impact in the stealth technology in that for vehicles shaped to provide a low frontal RCS, these edge waves become a dominant contributor as has been confirmed by experiment. They represent the missing component in our analysis of the RCS of such vehicles and we are incorporating their contribution in the appropriate computer codes. All of the analysis developed in our diffraction studies will be incorporated in such codes. Earlier versions for reflector antennas, antennas mounted on aircraft, etc., have been widely distributed to industry for costs corresponding to cost of materials. The requests for these codes continually increase and they make a remarkable mechanism for transferring the technology to industry.

4) The Time Domain or Transient Studies under JSEP have been used to develop, among other uses, target identification techniques which have proven to be very successful. Some of them have been applied (on other programs) to correctly identify a naval vessel using scattered field data provided by the Navy. Most of this work has been transferred to other ONR programs during the last year.

The high resolution capabilities of the compact range radar system was also originated under this JSEP program and we can resolve scattering centers that are separated by less than an inch. Using this same system, we have also very

accurately measured the impulse response of a spherically capped cylinder. This has been compared successfully with the computed impulse response.

Even though the K-pulse has been a subject of interest to us as a potential electromagnetic tool, it has not been the subject of much attention until very recently primarily because the study of the above transient techniques have required most of our attention. Last year as these others were transferred to other funding sources, this changed and we have successfully completed the generation of the K-pulse directly in time domain without first finding the natural resonance. This technique is applicable to the low Q types of targets. In fact, all of the major tools required for applying the K-pulse concept to tasks in target identification, antenna development and resonant cross section control now appear to be in hand. In addition to the above solution for the K-pulse, a pole elimination concept has been used to treat a circular loop and should be applicable to other resonant scatterers. It is noted that most of these successes have been achieved in the last year of this program.

5, The Integral Equation Studies have provided a vast simplification of the analysis of penetrable bodies using two different approaches. One of these used the Green's function of a conducting half plane and treats the scattering of penetrable materials placed on that half-plane.

In the second approach, the physical basis concept (with only three unknowns) was developed for certain large penetrable scatterers with a vast saving of computation time and and an equally vast understanding of the scattering mechanisms involved.

An integral equation solution has been obtained for conducting polygonal plates. This solution has been used to generate a computer code for the low frequency electromagnetic scattering from shapes such as aircraft and missiles. The results have been successfully compared to experimental data.

6, Microstrip antennas have been treated in several work units included in the Hybrid Studies and the Integral Equation studies. The case of a microstrip antenna on a dielectric coated cylinder yielded an exact eigenfunction solution and an asymptotic solution. A simple approximation for the surface Green's function has been obtained for a 2-D planar and convexly curved conducting surface with a thin dielectric coating. This should be very useful in the study of such microstrip antennas.

LISTING OF PRINCIPAL INVESTIGATORS

1983-1985

1. Professor R.G. Kouyoumjian
2. Professor D.L. Moffatt
3. Dr. E.H. Newman
4. Professor P.H. Pathak
5. Professor J.H. Richmond
6. Dr. N. Wang
7. Dr. J.D. Young
8. Dr. C.D. Chuang

DEGREES AWARDED

Over the past 3 years with the support of JSEP 5 students have been granted M.Sc. degrees in Electrical Engineering and 8 students have been granted the Ph.D. degree at the Ohio State University. The following lists tablulates these students and gives the quarter of their graduation.

Master of Science Degrees

William J. Leeper, Spring 1983
Photios A. Alexandroupoulos, Summer 1983
Sivasankaran Srikanth, Winter 1984
Richard Kautz, Summer 1984
Akio Nagamune, Spring 1985

Ph.D. degree

Jamaledin Izadian, Winter 1983
Mark R. Schrote, Summer 1983
Ted. C. Lee, Winter 1984
Osman M. Buyukdura, Autumn 1984
Bing W. Kwan, Autumn 1984
Robert J. Paknys, Winter 1985
Roberto G. Rojas, Winter 1985
William J. Kent, Spring 1985

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1. J.L. Volakis and L. Peters, Jr., "Improved Identification of Underground Targets Using Video Pulse Radars by Elimination of Undesired Natural Resonances, IEEE Trans. on Antennas and Prop., Vol. AP-31, No. 2, pp. 334-340, March 1983.

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12. J.H. Richmond, "Monopole Antenna on Circular Disk", IEEE Trans. on Antennas and Propagation, Vol. AP-32, No. 12, pp. 1282-1287, December 1984.

13. D.L. Moffatt and T.C. Lee, "Time-Dependent Radar Target Signature, Synthesis and Detection of Electromagnetic Authenticity Features", Inverse Methods in Electromagnetic Imaging-Part 1, pp. 441-460, D. Reidel Publishing Co., Netherlands, 1985.

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4. R. Paknys and N. Wang, "Creeping Wave Propagation Constants and Modal Impedance for a Dielectric Coated Cylinder", paper to be published in IEEE Trans. Antennas and Propagation.

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7. R.G. Kouyoumjian and P.H. Pathak, "A Uniform GTD Approach to EM Scattering and Radiation", *to appear in* Handbook on Acoustic, Electromagnetic and Elastic Wave Scattering - Theory and Experiment, Vol. I, edited by B.K. Varadan and V.V. Varadan, North Holland.

8. P.H. Pathak, "Techniques for High Frequency Problems", to appear in the Antenna Handbook, edited by Y.T. Lo and S.W. Lee, ITT Howard W. Sams and Co., Inc.

9. P.H. Pathak, R.G. Rojas, "A Uniform GTD Analysis of EM Diffraction by an Impedance Discontinuty in a Planar Surface", Journal of Wave-Material Interaction, expected to appear in January 1986.

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1. F. Fok and J. Young, "Space Frequency Sampling Criteria for Electromagnetic Scattering of A Finite Object", submitted to IEEE Trans. on Antennas and Propagation.

2. E.H. Newman, TM and TE Scattering by a Dielectric/Ferrite Cylinder in the Presence of a Half-Plane", submitted to IEEE Trans. on Antennas and Propagation.

3. R.G. Kouyoumjian and O.M. Buyukdura, "Diffraction by a Discontinuity in Surface Curvature", submitted to IEEE Transactions on Antennas and Propagation.

4. L. Ersoy and P.H. Pathak, "Radiation by Sources on an Impedance Surface Patch Which Partly Covers a Perfectly-Conducting Convex Cylinder", submitted to the IEEE Trans. on Antennas and Propagation.

5. P.H. Pathak and R.G. Rojas, "A Uniform GTD Analysis of the EM Diffraction by a Thin Dielectric/Ferrite Half Plane - 2-D Case", submitted to IEEE Trans. on Antennas and Propagation.

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2. O.M. Buyukdura and R.G. Kouyoumjian, "The Radiation from Scatterers at the Edge of a Wedge".

3. O.M. Buyukdura and R.G. Kouyoumjian, "An Improved UTD Solution for Wedge Diffraction".

4. R. Paknys and N. Wang, "High Frequency Surface Field by a Magnetic Line Source on an Impedance Cylinder-Uniform Solution".

5. R.G. Rojas and P.H. Pathak, "A Uniform GTD Analysis of the EM Diffraction by a Thin Dielectric/Ferrite Half Plane - 3-D Case".

6. B.W. Kwan, E.H. Newman and R.G. Kouyoumjian, "Eigenfunction Solution for Mutual Coupling Between Microstrip Antennas on a Coated Dielectric Cylinder".

7. B.W. Kwan, R.G. Kouyoumjian and E.H. Newman, "Asymptotic Solution for Mutual Coupling Between Strips on a Dielectric Coated Cylinder".

8. J.H. Richmond, "The Variational Property of the Moment Method".

9. R.A. Hill, J.H. Richmond and L. Peters, Jr., "Surface Waves on a Planar Ferrite Slab".

10. C.W. Chuang, P.H. Pathak, and C.C. Huang, "Ray Analysis of Reflection from Open-end Circular and Rectangular Waveguides".

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2. William J. Leeper, "Identification of Scattering Mechanisms from Measured Impulse Response Signatures of Several Conducting Bodies", M.Sc. Thesis, The Ohio State University, Columbus, Ohio, Spring 1983.

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